TRANSPARENT TOUCH PANEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a transparent touch panel used for operating various electronic apparatuses.

2. Background Art

Recently, according as an electronic apparatus has been more functional and diversified, the electronic apparatus having a transparent touch panel mounted on a front surface of its display device such as a liquid crystal device has been increased. A character, sign, pattern, letter or the like which is shown on the display device, is visually identified and selected using the transparent touch panel, and functions of the electronic apparatus are switched by operation of the transparent touch panel.

The conventional transparent touch panel mentioned above is described hereinafter with reference to Fig. 2. The conventional transparent touch panel has light transmitting sheet 7. Light transmitting sheet 7 has light transmitting upper film 1 such as polyethylene terephthalate or polycarbonate, light transmitting lower film 2 and acrylic adhesive layer 3 for sticking upper film 1 to lower film 2. Undercoat layer 4 is formed on a lower surface of lower film 2, and upper electrical conductive layer 5 such as indium oxide tin or tin oxide is formed on undercoat layer 4 using a vacuum sputtering method or the like. Hard coat layer 6 is formed on an upper surface of upper film 1.

Undercoat layer 9 and lower electrical conductive layer 10 are formed on an upper surface of light transmitting substrate 8 such as a polyethylene terephthalate film, glass, or acrylic, in the same way as lower film 2. A

plurality of dot spacers 11 are formed on an upper surface of conductive layer 10 at a predetermined intervals for keeping a certain space to conductive layer 5, where dot spacers 11 are made of insulating resin such as epoxy resin or silicone resin.

Then, sheet 7 and substrate 8 are stuck to each other at their outer peripheries using frame shaped spacer 12 of which adhesive is applied on an upper surface and a lower surface so that conductive layer 5 confronts conductive layer 10 with a predetermined space. Thus, the transparent touch panel is constructed.

In the transparent touch panel discussed above, upper lead electrodes (not shown) are formed on both sides of conductive layer 5, and lower lead electrodes (not shown) are formed on both sides of conductive layer 10 in an orthogonal direction for the upper lead electrodes. Upper and lower lead electrodes are coupled with a detector (not shown) of the electronic apparatus via a connector for coupling. When an upper surface of sheet 7 is pressed with a finger, a pen or the like, sheet 7 is bent, so that upper electrical conductive layer 5 contacts with lower electrical conductive layer 10 at the pressed point.

The pressed point is detected by a resistance ratio between the upper lead electrode and the lower lead electrode using the detector, so that functions of the electronic apparatus are switched.

However, in the conventional transparent touch panel discussed above, when a certain point of the upper surface of sheet 7 is continuously pressed by strong force through the finger or the operational pen, gel type adhesive layer 3 is pressed and moves toward a circumference of the pressed point. Thus, a thickness at the pressed point becomes thin. As a result, a dent tends to remain on an upper surface of upper film 1 even when the pen is removed, or upper electrical conductive layer 5 at the pressed point tends to be damaged.

SUMMARY OF THE INVENTION

The present invention is directed to provide a transparent touch panel where a dent is hardly generated on a film and an electrical conductive layer is hardly damaged even when an upper surface of the transparent touch panel is continuously pressed by strong force.

The transparent touch panel of this invention includes a sheet formed by sticking an upper film to a lower film via a rubber elastic layer, where the upper film and the lower film each has a light transmitting characteristic and a thickness of 150 μm or less.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a sectional view of a transparent touch panel in accordance with a first exemplary embodiment of the present invention.

Fig. 2 shows a sectional view of a conventional transparent touch panel.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

A transparent touch panel of this invention includes a sheet formed by sticking an upper film to a lower film via a rubber elastic layer, where the upper film and the lower film each has a light transmitting characteristic and a thickness of 150 μm or less. In this structure mentioned above, the rubber elastic layer immediately returns by its elastic force when certain force is applied to and removed from the touch panel. As a result, the transparent touch panel where a dent is hardly generated on a film and an electrical conductive layer is hardly damaged can be obtained. This effect can not be obtained by using a conventional gel type adhesive layer.

In the transparent touch panel of this invention, the rubber elastic layer

is made of silicone rubber preferably having the following characteristics:

a) hardness of 10-70 (condition of measurement: scale A of Rockwell hardness test in Japanese Industrial Standards),

b) a compressive permanent distortion factor of 50 % or less (condition of measurement: 70 °C 22 hours of B method in American Society for Testing and Material),

c) total light transmittance of 90% or more, and

d) a thickness of 5 μm or more.

Heat resistance is improved by using the rubber elastic layer compared to rubber such as polyuretane or acrylic, so that the touch panel can be used even at a high temperature.

Furthermore, the transparent touch panel of this invention preferably has a hard coat layer on an upper surface of the sheet. Wear resistance is improved by forming the hard coat layer, so that the surface of the sheet is prevented from damage caused by a finger, a pen or the like in operation.

The exemplary embodiment of this invention is described hereinafter with reference to Fig. 1. A dimension of a thickness is enlarged in Fig. 1 for easily understanding the structure.

Embodiment

As shown in Fig. 1, the transparent touch panel of this invention has light transmitting sheet 27. Light transmitting sheet 27 has second light transmitting film 21 (hereinafter referred to as "upper film 21"), first light transmitting film 22 (hereinafter referred to as "lower film 22") and rubber elastic layer 23 for sticking upper film 21 to lower film 22. In addition, undercoat layer 24 and first electrical conductive layer 25 (hereinafter referred to as "upper electrical conductive layer 25") are formed on a lower surface of

lower film 22, and hard coat layer 26 is formed on an upper surface of upper film 21.

Upper film 21 and lower film 22 are light transmitting films of 150 μm thickness or less and made of polyethylene terephthalate, polycarbonate or the like.

Rubber elastic layer 23 is made of silicone rubber having the following characteristics:

a) hardness of 10-70 (condition of measurement: scale A of Rockwell hardness test in Japanese Industrial Standards),

b) a compressive permanent distortion factor of 50 % or less (condition of measurement: 70 °C, 22 hours of B method in American Society for Testing and Material),

c) total light transmittance of 90% or more, and

d) a thickness of 5 μm or more.

Besides the adherent silicone rubber, fluorine rubber can be used as rubber elastic layer 23. In addition, though heat resistance does not improve compared to the silicone rubber, polyuretane rubber, acrylic rubber, ethylene-propylene rubber, isoprene rubber, butadiene rubber, polystyrene base thermoplastic elastomer, 1,2-polybutadiene base thermoplastic elastomer or the like can be also used. Using cross-linkable transparent silicone adhesive, superior heat resistance and transparency can be obtained, and volatile solvent or the like hardly occurs and remains in a manufacturing process. As a result, efficiency, reliability and productivity can be improved. Undercoat layer 24 is made of silica or phenoxy resin, and upper electrical conductive layer 25 is made of indium tin oxide, tin oxide or the like formed by a vacuum sputtering method or the like. Hard coat layer 26 is made of transparent material such as acrylic resin.

Undercoat layer 29 and second electrical conductive layer 30 (hereinafter referred to as "lower electrical conductive layer 30") are formed on an upper surface of light transmitting substrate 28.

A plurality of dot spacers 31 are formed on an upper surface of lower electrical conductive layer 30 at a predetermined intervals for keeping a certain space to upper electrical conductive layer 25, where dot spacers 31 are made of insulating resin such as epoxy resin or silicone resin. A polyethylene terephthalate film, glass, acrylic or the like can be used as light transmitting substrate 28.

Then, sheet 27 and substrate 28 are stuck to each other at their outer peripheries using frame shaped spacer 32 of which adhesive is applied on an upper surface and a lower surface so that upper electrical conductive layer 25 confronts lower electrical conductive layer 30 with a predetermined space. Thus, the transparent touch panel of this invention is constructed.

In the transparent touch panel discussed above, upper lead electrodes (not shown) are formed on both sides of upper electrical conductive layer 25, and lower lead electrodes (not shown) are formed on both sides of lower electrical conductive layer 30 in an orthogonal direction for the upper lead electrodes. Upper and lower lead electrodes are coupled with a detector (not shown) of an electronic apparatus via a connector for coupling. When an upper surface of sheet 27 is pressed with a finger, a pen or the like, sheet 27 is bent, so that upper electrical conductive layer 25 contacts with lower electrical conductive layer 30 at the pressed point. The detector detects the pressed point using a resistance ratio between the upper lead electrode and the lower lead electrode, so that functions of the electronic apparatus can be controlled or switched.

A manufacturing method and an evaluating method of the transparent touch panel of this invention are described hereinafter in detail.

Undercoat layer 24 and upper electrical conductive layer 25 have been formed on a lower surface (i.e., a surface of one side) of lower film 22 (e.g., "300RKW", PET film of 25 μm thickness manufactured by Toyobo Co., Ltd.). Rubber elastic layer 23 made of silicone rubber (e.g., "super transparent silicone rubber" manufactured by Asahi Rubber Inc.) is joined to lower film 22. Then a lower surface of upper film 21 having hard coat layer 26 on the upper surface is joined to an upper surface of rubber elastic layer 23. After that, upper film 21 and lower film 22 are stuck to each other by cross-linking the rubber, thereby making light transmitting sheet 27. PET film of 125 μm thickness is used as upper film 21. In this embodiment, sheet-type silicone-rubber adhesive is used for improving productivity, however, the same efficiency can be obtained using liquid-type silicone-rubber adhesive.

Then, sheet 27 is stuck to substrate 28, of which lower electrical conductive layer 30 and dot spacers 31 are formed on an upper surface, using frame shaped spacer 12 of which adhesive is applied on an upper surface and a lower surface. Thus, the transparent touch panel of this embodiment is provided.

Comparative example

Undercoat layer 4 and upper electrical conductive layer 5 has been formed on lower film 2 of 25 μm thickness, and hard coat layer 6 has been formed on upper film 1 of 125 μm thickness. Lower film 2 is stuck to upper film 1 using acrylic adhesive 3 (e.g., "Scotch 8141" of 25 μm thickness manufactured by 3M), thereby making light transmitting sheet 7. Sheet 7 is stuck to substrate 8, of which lower electrical conductive layer 10 and dot spacers 11 are formed on an upper surface, using frame shaped spacer 3 of which adhesive is applied on an upper surface and a lower surface. Thus, a transparent touch

panel of the comparative example is provided.

Pr ssur test

Upper surfaces of sheet 27 and sheet 7 are continuously pressed by 2.5 N load for 30 minutes using a polyacetal-made pen whose tip shape is a sphere of R 0.8mm. After the pressure test mentioned above, whether a dent is generated or not is inspected. As a result, in the comparative example, when the load is removed, a dent is generated on the upper surfaces of sheet 7 which is stuck with acrylic adhesive. However, in this embodiment, when the load is removed, sheet 27 immediately returns by its elastic force and a dent is not observed.

Sliding test

Upper surfaces of sheet 27 and sheet 7 are pressed by 5N load using the pen mentioned above, and the pen is slid and reciprocated for a length of 30mm at 2000 times / hour. After the sliding test mentioned above, whether the electrical conductive layer is damaged or not is inspected. As a result, damage is observed at conventional sheet 7, where the acrylic adhesive is used, at reciprocating movements of 200 thousands times. However, damage is not observed on sheet 27 of this embodiment even after reciprocating movements of 300 thousands times.

In the pressure test and the sliding test mentioned above, conventional gel type adhesive is pressed and moves toward a circumference of the pressed point by pressing, so that a thickness at the pressed point becomes thin and elasticity deteriorates. On the contrary, solid rubber elastic layer 23 of this invention keeps its elasticity during the tests, and works as a buffer for upper electrical conductive layer 25.

As discussed above, the transparent touch panel where a dent is hardly generated and the upper electrical conductive layer is hardly damaged can be obtained using this invention.